STATE OF WASHINGTON

STATE BUILDING CODE COUNCIL

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Low Carbon District Heating/ Cooling
TAG Revision 8/20/21
Workgroup Revision 8/23/21

Washington State Energy Code Development

Standard Energy Code Proposal Form

Code being amended: ☒ Commercial Provisions ☐ Residential Provisions

Code Section # C407.3 Performance-based Compliance and associated definitions in C202

Brief Description:

Add a definition of *low-carbon district heating and cooling (or heating only) system* to C202 and clarify how credit can be claimed in a C407 Total Building Performance analysis for utilizing low-carbon district heating or cooling.

Proposed code change text: (Copy the existing text from the Integrated Draft, linked above, and then use underline for new text and ~~strikeout~~ for text to be deleted.)

C202 GENERAL DEFINITIONS (add the following definitions, which should be consistently defined if any other district energy related code proposals are adopted):

LOW-CARBON DISTRICT HEATING AND COOLING OR HEATING ONLY SYSTEM. Any system serving multiple buildings providing energy in the form of direct heating and cooling, or heating only to a building. Energy can be directly converted to meet building heating or cooling loads through a heat exchanger ~~without requiring additional mechanical system input~~. Examples include, but are not limited to steam, hot water, and chilled water.

~~Documentation for the l~~Low-carbon district system must ~~be available to~~ demonstrate the following:

1. Distribution losses must be accounted for and may not exceed 10% of the annual load delivered to buildings served by the system.

2.1 25% of the annual district-system-net-load-met (sum of heating and cooling energy provided to attached buildings) comes from heat recovery between connected buildings, waste heat, or *renewable energy resources* and no more than 25% of the annual heat input to the system comes from fossil fuel or electric-resistance sources.

or

2.2 No more than 10% of the system annual heat input to the system comes from fossil fuel or electric-resistance sources.

C407.3.2 Utilization of low-carbon district energy

C407.3.2.1 Utilization of low-carbon district heating and cooling, or heating only systems. Applicable if heating and cooling or heating only is provided to the proposed building from *a low-carbon district heating and cooling, or heating only system* that is fully operational prior to the final inspection. Proposed model shall account for all on-site HVAC and Service Hot Water related equipment, such circulation pump energy and heat-exchanger efficiency.

1. The following modifications ~~are made~~ shall be applied to the ASHRAE Standard 90.1 Appendix G, Performance Rating Method, in addition to what is described in C407.3.

    a. For *low-carbon district heating and cooling systems* strike the text of Sections G3.1.1.1, G3.1.1.2, G3.1.1.3.1, and G3.1.1.3.4. Baseline systems shall be selected based on un-modified version of Tables G3.1.1-3 and G3.1.1-4, with carbon emission factors from Table C407.3(1).
    b. For *low-carbon district heating only systems* strike the text of Sections G3.1.1.1, G3.1.1.3.1, and G3.1.1.3.4. Baseline system shall be selected based on un-modified version of Tables G3.1.1-3 and G3.1.1-4, with carbon emission factors from Table C407.3(1).
2. Any heating or cooling energy provided by the *low-carbon district heating and cooling, or heating only system* ~~will~~ shall utilize footnote a of Table C407.3(1) for the district system carbon emission factor in the proposed model.
3. ~~Cooling energy~~Waste heat exported from the building to the *low-carbon district heating and cooling, or heating only system* shall not be considered purchased energy. ~~Exported cooling energy~~Carbon emissions from the waste heat exported shall be ~~subtracted from~~ accounted for in the proposed design carbon emissions at the seasonal factors below. The exported energy emissions credit shall be calculated based on footnote a of Table C407.3(1).
    a. 50% of the ~~cooling energy exported~~waste heat exported during the months of October through December and January through March.
    b. 25% of the ~~cooling energy~~ waste heat exported during the months of April through September.

    Exception to Item 3: Waste heat exported from the building to the low-carbon district heating and cooling, or heating only system shall not be subtracted from the proposed design carbon emissions if they are already accounted for in the calculation of emissions from the district heating or cooling plant.

Documentation for the low-carbon district system that is operational prior to the final inspection shall be provided to demonstrate that the definition of *low-carbon district heating and cooling or heating only system* is satisfied. ~~the following:~~

~~Distribution losses must be accounted for and may not exceed 10% of the annual load delivered to buildings served by the system.~~

~~25% of the annual district system net load met (sum of heating and cooling energy provided to attached buildings) comes from heat recovery between connected buildings, waste heat, or *renewable energy resources* and no more than 25% of the annual heat input to the system comes from fossil fuel or electric resistance sources.~~

~~or~~

~~4. No more than 10% of the system annual heat input to the system comes from fossil fuel or electric resistance sources.~~

C403.1.4 (ADD EXCEPTION BELOW)

#. Low-carbon district energy systems that meet the definitions of *low-carbon district energy exchange system or a low-carbon district heating and cooling or heating only systems*.

Purpose of code change:

District energy systems which utilize low-carbon fuel sources should be encouraged as a method for achieving the state's targeted carbon emission reductions. Proposed language adds more options for projects that utilize a low-carbon district energy system to achieve prescriptive code compliance in section C406.

Partial credit (in the form of claimable carbon emission reductions) for cooling-dominated buildings is proposed to encourage the most efficient operation of these district systems (allowing for diverse loads and heat-recovery). This credit is NOT available for cooling only district systems (no heat recovery potential), which are not included in this definition).

Definition could be tweaked in future code cycles to reduce the portion of district energy coming from non-renewable or fossil fuel sources.

Note that this proposal includes excludes CHW-only district energy systems, as they do not offer the same opportunities to reduce net carbon emissions (heat rejection on-site with cooling towers utilizes significant amounts of water but not energy).

Excerpts from ASHRAE 90.1-2019 for reference:

G3.1.1.1 Purchased Heat

For *systems* using purchased hot water or steam, the heating source shall be modeled as purchased hot water or steam in both the *proposed design* and *baseline building design*. Hot-water or steam costs shall be based on actual utility rates, and on-site *boilers*, electric heat, and furnaces shall not be modeled in the *baseline building design*.

G3.1.1.2 Purchased Chilled Water

For *systems* using purchased chilled water, the cooling source shall be modeled as purchased chilled water in both the *proposed design* and *baseline building design*. Purchased chilled-water costs shall be based on actual utility rates, and on-site chillers and direct expansion *equipment* shall not be modeled in the *baseline building design*.

G3.1.1.3 Baseline HVAC System Requirements for Systems Utilizing Purchased Chilled Water and/or Purchased Heat

If the *proposed design* uses purchased chilled water and/or purchased heat, the following modifications to the baseline *HVAC system* types in Table G3.1.1-4 shall be used.

G3.1.1.3.1 Purchased Heat Only

If the *proposed design* uses purchased heat, but does not use purchased chilled water, then Tables G3.1.1-3 and G3.1.1-4 shall be used to select the baseline *HVAC system* type, and purchased heat shall be substituted for the heating type in Table G3.1.1-4. The same heating source shall be used in the *proposed design* and *baseline building design*.

G3.1.1.3.2 Purchased Chilled Water Only

If the *proposed design* uses purchased chilled water but does not use purchased heat, then Tables G3.1.1-3 and G3.1.1-4 shall be used to select the baseline *HVAC system* type, with the modifications listed below:

a. Purchased chilled water shall be substituted for the cooling types in Table G3.1.1-4.
b. *System* 1 and 2 shall be constant-volume fan-coil units with *fossil fuel boilers*.
c. *System* 3 and 4 shall be constant-volume single-zone air handlers with *fossil fuel* furnaces.
d. *System* 7 shall be used in place of *System* 5.
e. *System* 8 shall be used in place of *System* 6.

G3.1.1.3.3 Purchased Chilled Water and Purchased Heat

If the *proposed design* uses purchased chilled water and purchased heat, then Tables G3.1.1-3 and G3.1.1-4 shall be used to select the baseline *HVAC system* type, with the following modifications:

a. Purchased heat and purchased chilled water shall be substituted for the heating types and cooling types in Table G3.1.1-4.
b. *System* 1 shall be constant-volume fan-coil units.
c. *System* 3 shall be constant-volume single-zone air handlers.
d. *System* 7 shall be used in place of *System* 5.

G3.1.1.3.4 On-Site Distribution Pumps

All on-site distribution pumps shall be modeled in both the *proposed design* and *base building design*.

Table G3.1.1-3 Baseline *HVAC System* Types

Building Type, Number of *Floors*, and Gross Conditioned Floor Area	Climate Zones 3B, 3C, and 4 to 8	Climate Zones 0 to 3A
Residential	*System* 1—*PTAC*	*System* 2—*PTHP*
Public assembly <120,000 ft^2	*System* 3—PSZ-AC	*System* 4—PSZ-HP
Public assembly ≥120,000 ft^2	*System* 12—SZ-CV-HW	*System* 13—SZ-CV-ER
Heated-only storage	*System* 9—Heating and *ventilation*	*System* 10—Heating and *ventilation*
Retail and 2 *floors* or fewer	*System* 3—PSZ-AC	*System* 4—PSZ-HP
Other nonresidential and 3 *floors* or fewer and <25,000 ft^2	*System* 3—PSZ-AC	*System* 4—PSZ-HP
Other nonresidential and 4 or 5 *floors* and <25,000 ft^2 or 5 *floors* or fewer and 25,000 ft^2 to 150,000 ft^2	*System* 5—Packaged *VAV* with *reheat*	*System* 6—Packaged *VAV* with PFP boxes
Other nonresidential and more than 5 *floors* or >150,000 ft^2	*System* 7—*VAV* with *reheat*	*System* 8—*VAV* with PFP boxes

Notes:
1. *Residential building* types include dormitory, hotel, motel, and multifamily. *Residential space* types include guest rooms, living quarters, private living space, and sleeping quarters. Other *building* and *space* types are considered *nonresidential*.
2. Where attributes make a *building* eligible for more than one baseline *system* type, use the predominant condition to determine the *system* type for the entire *building* except as noted in Section G3.1.1.
3. For laboratory *spaces* in a *building* having a total laboratory exhaust rate greater than 15,000 cfm, use a single *system* of type 5 or 7 serving only those *spaces*.
4. For hospitals, depending on *building* type, use *System* 5 or 7 in all climate zones.
5. Public assembly *building* types include houses of worship, auditoriums, movie theaters, performance theaters, concert halls, arenas, enclosed stadiums, ice rinks, gymnasiums, convention centers, exhibition centers, and natatoriums.

Table G3.1.1-4 Baseline *System* Descriptions

System No.	*System* Type	Fan *Control*	Cooling Type [a]	Heating Type [a]
1. *PTAC*	*Packaged terminal air conditioner*	Constant volume	Direct expansion	Hot-water *fossil fuel boiler*
2. *PTHP*	*Packaged terminal heat pump*	Constant volume	Direct expansion	Electric heat pump
3. PSZ-AC	Packaged rooftop air conditioner	Constant volume	Direct expansion	*Fossil fuel* furnace
4. PSZ-HP	Packaged rooftop heat pump	Constant volume	Direct expansion	Electric heat pump
5. Packaged *VAV* with *reheat*	Packaged rooftop *VAV* with *reheat*	*VAV*	Direct expansion	Hot-water *fossil fuel boiler*
6. Packaged *VAV* with PFP boxes	Packaged rooftop *VAV* with parallel fan power boxes and *reheat*	*VAV*	Direct expansion	*Electric resistance*
7. *VAV* with *reheat*	*VAV* with *reheat*	*VAV*	Chilled water	Hot-water *fossil fuel boiler*
8. *VAV* with PFP boxes	*VAV* with parallel fan-powered boxes and *reheat*	*VAV*	Chilled water	*Electric resistance*
9. Heating and *ventilation*	Warm air furnace, gas fired	Constant volume	None	*Fossil fuel* furnace
10. Heating and *ventilation*	Warm air furnace, electric	Constant volume	None	*Electric resistance*
11. SZ–*VAV*	Single-zone *VAV*	*VAV*	Chilled water	See note (b).
12. SZ-CV-HW	*Single-zone system*	Constant volume	Chilled water	Hot-water *fossil fuel boiler*
13. SZ-CV-ER	*Single-zone system*	Constant volume	Chilled water	*Electric resistance*

a. For purchased chilled water and purchased heat, see G3.1.1.3.
b. For Climate Zones 0 through 3A, the heating type shall be *electric resistance*. For all other climate zones the heating type shall be hot-water fossil-*fuel boiler*.

Your amendment must meet one of the following criteria. Select at least one:

☐ Addresses a critical life/safety need.

☐ The amendment clarifies the intent or application of the code.

☒ Addresses a specific state policy or statute.
(Note that energy conservation is a state policy)

☐ Consistency with state or federal regulations.

☐ Addresses a unique character of the state.

☐ Corrects errors and omissions.

Check the building types that would be impacted by your code change:

☐ Single family/duplex/townhome	☒ Multi-family 4 + stories	☒ Institutional
☐ Multi-family 1 – 3 stories	☒ Commercial / Retail	☐ Industrial

Your name	Clarence Clipper	Email address	clarence.clipper@centrioenergy.com
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Other contact name	Click here to enter text.		

Economic Impact Data Sheet

Briefly summarize your proposal's primary economic impacts and benefits to building owners, tenants and businesses.

The biggest economic benefit of this proposal is that it introduces more options for projects to comply with energy code and invest in systems that provide long-term lower carbon operation. The ability to connect to a low carbon district HW/CHW system might be particularly attractive to existing buildings undergoing significant mechanical system replacement that likely do not have the mechanical space or structural capabilities required to retrofit with air-to-water-heat-pumping or heat recovery equipment. As more heat-pumping requirements are introduced to code, retrofits and existing buildings will have a hard are harder time complying with code unless more options are available.

Project capital cost savings can be significant for projects that only have to provide heat-exchangers instead of on-site heating and cooling equipment, and yet still source their heating and cooling from low carbon sources. This also frees up mechanical space that would otherwise have to be dedicated to heating and cooling equipment.

Provide your best estimate of the construction cost (or cost savings) of your code change proposal? (See OFM Life Cycle Cost **Analysis tool** and **Instructions;** use these **Inputs**. **Webinars on the tool can be found Here and Here**)

$2.00-5.00/square foot ROM Capital Cost Savings (For residential projects, also provide $ / dwelling unit)

Show calculations here, and list sources for costs/savings, or attach backup data pages

A project receiving HW and CHW from a district energy system only requires heat exchangers and pumps on-site vs. a stand alone plant that requires boilers and/or heat pumps for heat addition, cooling towers or fluid coolers for heat rejection and chillers or heat pumps for cooling and heat recovery.

Provide your best estimate of the annual energy savings (or additional energy use) for your code change proposal?

See energy discussion below - Highly dependent upon connected building loads) KWH/ square foot (or) KBTU/ square foot

(For residential projects, also provide KWH/KBTU / dwelling unit)

Show calculations here, and list sources for energy savings estimates, or attach backup data pages

Energy modeling of projects that have both office and residential towers on immediately adjacent sites (and thus can implement direct energy exchange between the cooling dominated offices and heating dominated residences), shows

that there is a significant increase in heat recovery potential when the projects can exchange energy compared to any heat recovery available within each individual project. For example, a stand-alone residential tower might be able to meet ~10-15% of its gross annual heating load (space heating, DHW, pool etc) from on-site recovered heat (cooling). However, when connected to an equivalent sized office tower, with year-round heat-rejection needs, 40-60% of the gross heating load can be met by heat-recovery equipment.

District HW/CHW plants with diverse heating and cooling loads can introduce heat recovery potential to a much wider range of projects than would ever consider incorporating energy recovery on a one-off-site basis, as many simply don't have enough complimentary heating and cooling loads to even bother.

The exact energy savings that can be expected vary significantly based on the balance of loads on a given district energy system, and there may be times when heat must be added by district equipment to maintain a minimum loop temperature. That is why this proposal introduces language to define a "low carbon district heating and cooling or heating only system" with minimum % of heat that must come from heat-recovery and maximum % of heat that can come from fossil fuels or electric resistance (values that can be modified by the TAG or in future code cycles). This would ensure that the energy code is only encouraging the most efficient district HW/CHW schemes while still allowing projects to gain the design flexibility introduced by connecting to such systems. The minimal allowance for fossil fuel or electric resistance inputs gives some flexibility for these large-scale systems to ramp up to full operation (year-one load balance might be significantly different than the established system operation).

List any code enforcement time for additional plan review or inspections that your proposal will require, in hours per permit application:

Having a clear set of rules for C407 energy modeling on these systems reduced the amount of project specific negotiations required by code officials. The overall project review times should be similar to any project utilizing a Total Building Performance analysis compliance approach. The district system provider will have to work with code officials to initially establish that their system meets the low carbon designation, thus opening the door for projects to connect and take advantage of the proposed code language.

All questions must be answered to be considered complete. Incomplete proposals will not be accepted.